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SOME APPLICATIONS OF RADIOACTIVE ISOTOPES IN VETERINARY RESEARCH*

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INTRODUCTION

The radioisotope technique is a comparatively new one but the speed of its development and the wideness of its application, within the last 10 years, have been most striking (see reviews by Hevesy, 1948 ; Kamen, 1951 ; and Wormall, 1951). Tracer methods are now being widely applied in biological investigations including the field of human medicine. The following paper illustrates some of the ways in which radioactive isotopes are being used on veterinary problems at the Glasgow School. By way of introduction a brief outline of the physical basis of the radioactive tracer technique is given.

Isotopes

It is now known that practically all the chemical elements exist as mixtures of two or more "isotopes," *i.e.*, atoms with the same nuclear charge (Atomic Number) but different nuclear masses (Atomic Weights). Since the chemical properties of an atom are determined by the number of planetary electrons which is in turn equal to the number of positive charges on the nucleus (Atomic Number), it follows that isotopes of an element will have the same chemical properties. It sometimes happens that one of the isotopes of an element is "radioactive," *i.e.*, its nucleus is unstable and disintegrates spontaneously with the emission of particles or rays. There are not many naturally occurring radioactive isotopes but in recent years it has become possible to prepare radioactive isotopes artificially.

Preparation of Radioactive Isotopes

Radioisotopes can be prepared by bombarding stable elements with neutrons, protons, deuterons, α particles. Where applicable neutron bombardment is the most efficient way of producing artificial radioactive isotopes. Of the particles mentioned above all are positively charged except the neutron, and hence they experience the effect of the potential barrier at the nucleus due to its positive charge. The neutron, having no charge, is immune from this effect. War-time research on nuclear fission with the development of the "atomic pile" (by far the most efficient source of neutrons yet developed) has increased enormously the production of artificial radioactive isotopes.

Two examples of the preparation of radioactive isotopes by neutron bombardment are given in the adjoining column. In each case the atomic weight is indicated at the top left of the symbol, the atomic number bottom left.

In the first example given a "transmutation" occurs and the phosphorus isotope is formed from a sulphur atom

$$\underset{16}{\overset{32}{}}\mathrm{S} + \underset{0}{\overset{1}{}}\mathrm{n} \rightarrow \underset{15}{\overset{32}{}}\mathrm{P} + \underset{1}{\overset{1}{}}\mathrm{H}$$

radioactive isotope of phosphorus, decays with emission of a β ray

$$\underset{11}{\overset{23}{}}\mathrm{Na} + \underset{0}{\overset{1}{}}\mathrm{n} \rightarrow \underset{11}{\overset{24}{}}\mathrm{Na} + \gamma$$

radioactive isotope of sodium, decays with emission of β and γ rays

and it is therefore possible to make a preparation of ^{32}P which contains little or no ordinary phosphorus. Such a preparation is described as "carrier free." Although the atomic pile is used most extensively in the preparation of radioisotopes, in certain special cases bombardment by particles accelerated in the cyclotron is still preferable. About 700 different radioisotopes have now been characterised and many are available in fair quantity for research and other purposes.

Radioactivity

When the nuclei of radioactive atoms disintegrate a variety of radiations are emitted, *i.e.*,

- α particles (helium nuclei)
- β particles (electrons, positrons)] particles
- γ rays
- X-rays] electromagnetic radiations

In the case of some isotopes only one type of radiation is produced ; with other isotopes some combination of the above may be emitted.

The rate at which a radioactive element decays follows the exponential law. The time during which half of the initial activity is lost is known as the "half-life." Each radioactive isotope has its own characteristic "half-life" which may vary from the order of seconds to thousands of years. The "half-life" is a very important consideration in choosing an isotope for a particular investigation.

Measurement of Radioactive isotopes

Methods used for the quantitative determination of radioactivity are almost all based on the capacity of the radiations to produce ionisation in a gas. The most widely used detector

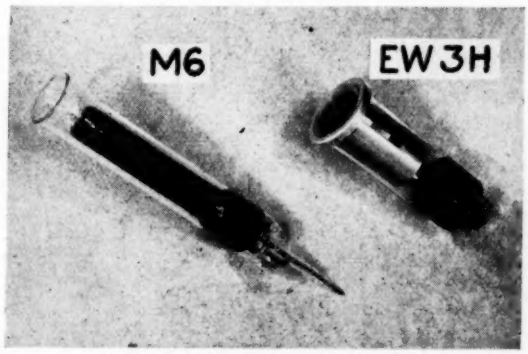

FIG. 1.—Geiger-Müller counters (20th Century Electronics).

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is the Geiger-Müller counter. There are many different types of Geiger counter for use with different isotopes and under different circumstances, but all work essentially on the same principle.

Fig. 1 shows two types used in this laboratory, an end window counter (EW3H) and a liquid counter (M6). The end window counter is used in assaying the radioactivity of solid samples obtained directly or as a result of precipitation, evaporation, etc. ; the liquid counter is used where determinations are being made directly on solutions. Because of variations in the energy and type of radiations emitted by different isotopes it is necessary to select a counter which is suitable for the particular isotope being used.

The Geiger counter is usually mounted in a lead " castle " to cut off extraneous radiations, and is connected to an electronic unit which amplifies the pulses from the tube and utilises them to operate a mechanical recording register such as a Post Office meter. Fig. 2 shows an example of a castle and recording unit as used in this laboratory.

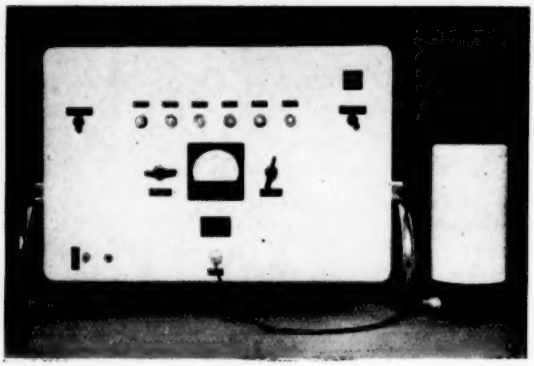


Fig. 2.—Recording unit and lead castle (Panax Ltd.).

It is impossible in the available space to give more than the barest outline of the theory behind the use of the radioactive tracer technique and although no mention has been made of such important aspects as the synthesis of labelled compounds, the preparation of material for counting, health hazards, counting errors, etc., it is hoped that the above skeleton will be useful to the uninitiated in appreciating the experimental work which follows.

Immunological Studies on Helminth Diseases

The part played by antibodies in helminth diseases is still somewhat obscure, although in many cases it is possible, by serological tests, to demonstrate the presence of circulating antibodies to the parasites (for references see Taliaferro, 1940 ; Soulsby, 1952). These serological tests have been used with varying degrees of success in diagnostic work. In some helminth diseases it does appear that previous immunisation can play an important part in inhibiting the development of the parasites (Schwartz, Alicata & Lucker, 1931 ; Urquhart, Mulligan & Jennings, 1954) ; in other cases it has been shown that treatment of larvae with immune serum significantly reduces their infectivity (Mauss, 1940 ; Otto, 1939).

The position regarding our knowledge of the immunological properties of helminth antigens is summed up by Craig & Faust (1951). " As yet very little critical work has been done in animal parasitology to determine the relative specificities of the protein, polysaccharide, and cholesterol fractions of whole antigen. This field deserves much more thorough investigation." In pursuing such an investigation it is desirable to be able to measure antigens and antibodies in units of weight rather than of titre, *i.e.*, it is necessary to adopt the analytical methods of quantitative immunochemistry (for a review of some of these methods see Kabat & Mayer, 1948).

Since antibodies are protein in nature, they can be measured in terms of protein nitrogen. In a precipitin test where the antigen is a nitrogen-free carbohydrate micro-Kjeldahl analysis of the specific precipitate gives its antibody nitrogen content directly. Where the antigen is also a protein, the precipitate will contain both antibody nitrogen and antigen nitrogen and in such circumstances it is necessary to get an independent measure of one or other of the reactants. This is possible in regions where complete precipitation of the added antigen has occurred or where the antigen contains some characteristic group which can be measured independently of protein nitrogen. In the reaction between a homogeneous protein antigen like ovalbumin and its homologous rabbit antiserum the precipitin curve obtained (Fig. 3)

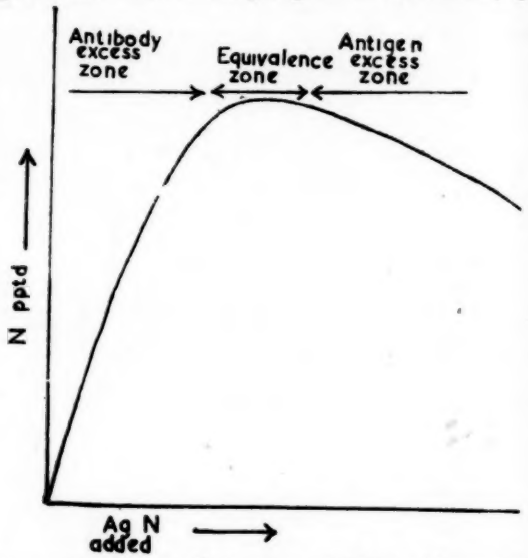


Fig. 3.—Typical precipitin curve obtained with ovalbumin and the homologous rabbit antiserum. The figure is obtained by adding increasing amounts of the antigen to a fixed amount of antiserum.

falls into three fairly well-defined zones, (*a*) an antibody excess zone, where it can be demonstrated that all the added antigen has been precipitated, (*b*) an equivalence zone corresponding to complete precipitation of both antigen and antibody, and (*c*) an antigen excess or antigen inhibition zone. In the equivalence zone, subtraction of the antigen nitrogen present from the total nitrogen precipitated gives a figure for the antibody nitrogen precipitated, and thus a figure for the specific antibody content of the serum.

In the case of inhomogeneous antigen preparations such as one is likely to obtain from extracts of helminths the above relationship no longer holds, *e.g.*, added antigen is not completely precipitated in the antibody excess zone and there is no clearly defined equivalence zone. In such cases it is necessary to employ a method which enables one to make a separate determination of antigen or antibody in the precipitate. One way in which this can be done is by the isotopic labelling of one of the reactants in the antigen-antibody system (see review by Wormall, 1952).

In our helminth work so far we have confined our attention to studies with labelled antibodies. The method of labelling

with ^{131}I is that described by Francis, Mulligan & Wormall (1951), and is outlined in Fig. 4. The results of the application

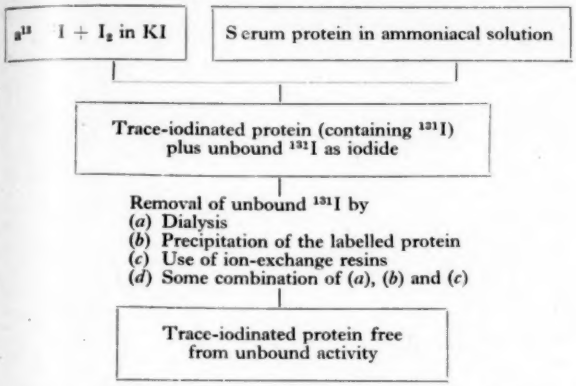

a^{11} I + I_2 in KI
Serum protein in ammoniacal solution
Trace-iodinated protein (containing ^{131}I) plus unbound ^{131}I as iodide
Removal of unbound ^{131}I by
(a) Dialysis
(b) Precipitation of the labelled protein
(c) Use of ion-exchange resins
(d) Some combination of (a), (b) and (c)
Trace-iodinated protein free from unbound activity

FIG. 4.—Trace-labelling of Serum Proteins with ^{131}I.

of this technique to one of our precipitin systems are shown in Fig. 5. The antiserum, prepared by immunising a rabbit

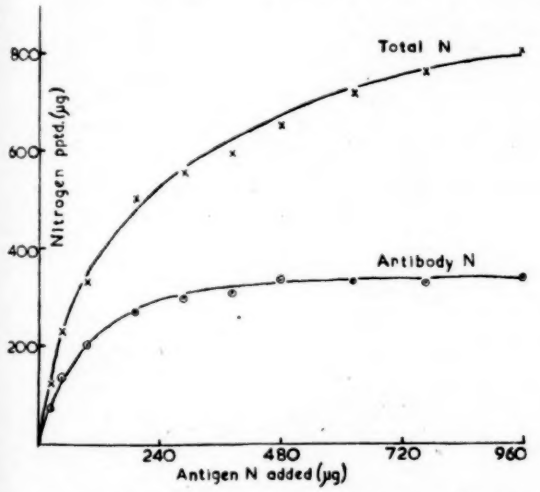


FIG. 5.—Curves obtained with the protein antigen from *F. hepatica* and antiserum trace-labelled with ^{131}I.

with a mixture of proteins from *Fasciola hepatica*, was trace-labelled with ^{131}I. The test antigen was a protein fraction of the parasite which precipitated at half-saturation with ammonium sulphate. The specific precipitates were analysed for total nitrogen and radioactivity, and the antibody nitrogen content calculated by comparing the radioactivity of the precipitates with that of a γ globulin standard prepared from the labelled serum and analysed for protein nitrogen. It can be seen from Fig. 5 that whereas the total nitrogen curve continues to rise the antibody nitrogen curve flattens off giving a measure of the total antibody nitrogen precipitated from the serum by this particular antigen.

In using ^{131}I-labelled antisera in such experiments it is necessary to appreciate that the different protein fractions in a sample of serum do not label at the same rate, *e.g.*, Pressman & Sternberger (1950) showed that in rabbit serum the albumin fraction labelled approximately three times as fast as the total globulins, and that the globulin fractions labelled at different rates, the α being fastest, the γ slowest. We are investigating this non-uniform labelling in the case of the domestic animals and are finding marked species variations. The results of some preliminary experiments are shown in Table I. Here

TABLE I
SPECIES VARIATIONS IN TRACE-IODINATION OF SERUM PROTEINS

Species	S.A. total protein/S.A. γ globulin
Horse	1·00
Rabbit	2·39
Sheep	1·62
Bovine	1·28
Human	1·28
Dog	1·39

whole serum was trace-labelled with ^{131}I, and the specific activity (S.A.) of the mixed serum proteins (radioactivity per μg. protein nitrogen) was compared with that of a sample of γ globulin separated from the same serum by Na_2SO_4 fractionation. The γ globulin preparations were checked for homogeneity by paper electrophoresis. Of the species so far investigated, in only the horse does the γ globulin label at the same rate as the total serum proteins. A similar result in the case of the horse has been reported by Cohen (1951).

In some immunochemical studies it is convenient to separate the antibody-containing fraction of the serum before labelling. This cannot usually be done without some loss, thus if one is interested in obtaining a figure for the total antibody of a serum precipitable by a particular antigen it is necessary to use labelled whole serum in the tests. When this is done a "standard" for the radioactivity determinations must be prepared from the antibody-containing fraction of the serum, *e.g.*, the γ globulin fraction used in the experiment in Fig. 5.

BLOOD VOLUME DETERMINATIONS ON DOMESTIC ANIMALS

Isotopic methods in blood volume determinations have become increasingly prominent over the past few years (see reviews by Reeve, 1948, 1952; and Gregerson, 1951). Red cells labelled with ^{32}P and plasma protein labelled with ^{131}I have been used extensively in blood volume studies on man and a number of the common laboratory animals, but only recently have the methods been applied to the domestic animals in general (Hansard, Butler, Comar & Hobbs, 1953; Jennings, Lauder & Mulligan, 1953).

Blood volume measurements using red cells labelled with ^{32}P are all based essentially on the experiments of Hevesy and his colleagues (1944). They demonstrated that red blood cells could be labelled with ^{32}P by incubating blood with a small amount of phosphate containing some of the radioactive isotope. During the incubation radioactive phosphate ions penetrate into the red cells and these tend to become fixed as organic phosphorus compounds (Hevesy, 1948). These labelled cells can be used for blood volume or circulating red cell volume determinations according to the ordinary dilution principle.

Early on in our work it became evident that there was a marked species variation in the uptake of ^{32}P by the red cells. This variation has been studied and the results are shown in Fig. 6. The relatively low permeability of horse red cells to radiophosphate had already been noted (Levi, 1945). In the case of bovines and horses because of their large blood volumes (60 to 70 litres in a draught horse) and the relatively poor permeability of their cells to radiophosphate, it seemed that the method might be rather expensive for routine use. It was found, however, that the efficiency of the labelling could be considerably increased if carried out on cells rather than whole blood (see Fig. 7). A further economy of ^{32}P can be effected by using whole blood samples for radioactivity

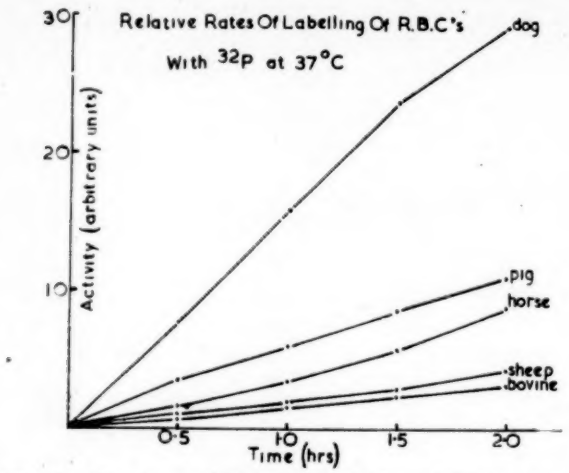


FIG. 6.—Species variations in the uptake of ^{32}P by red cells.

determination rather than diluted samples. In counting these whole blood samples it is desirable to lyse the cells by adding some surface active agent. The scheme followed in a blood volume determination on a horse is shown in Fig. 8.

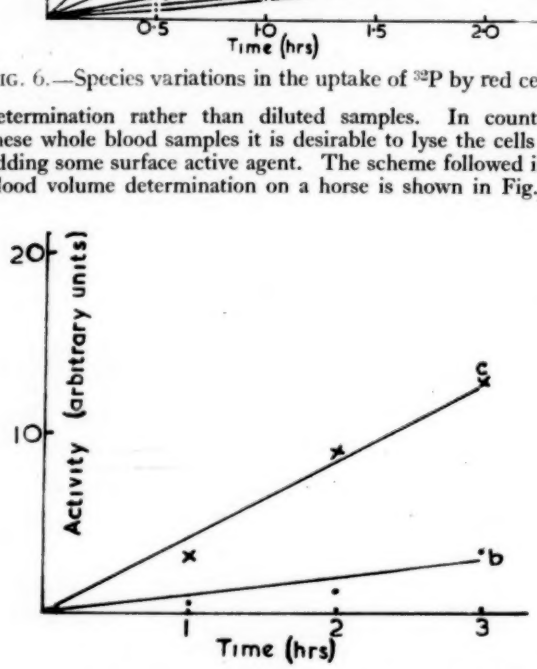


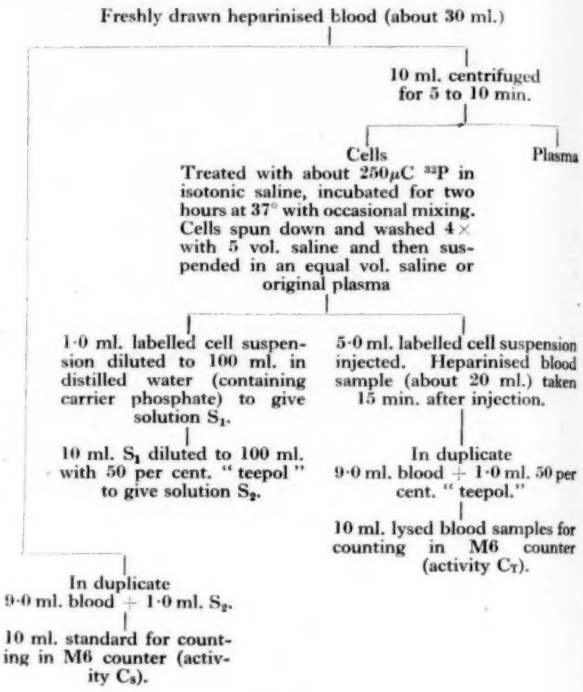
FIG. 7.—Comparative efficiency of the two labelling methods.

Curve b—Radioactivity of cells obtained by incubating whole blood with a fixed amount of ^{32}P.

Curve c—Radioactivity of cells obtained by incubating cells from the same quantity of blood with the same amount of ^{32}P.

We normally use about 250 μ C ^{32}P for each animal ; but a satisfactory, though more time consuming, determination can be made with as little as 50 μ C. The method used for the other domestic animals is essentially the same as that described for the horse, except that with the smaller animals less ^{32}P is required and radioactivity measurements can often be made on samples containing 1 or 2 ml. blood diluted to 10 ml. These are rather easier to pipette than the $9 \rightarrow 10$ dilution of whole blood used for the horse.

The other isotopic method which we are using (plasma proteins trace-labelled with ^{131}I) is essentially a method for measuring plasma volume. It has been recognised for some time that blood volumes based on measurements with labelled red cells are usually significantly lower than the figures obtained with the dye methods or with labelled serum proteins (see Gregerson, 1951). The explanation which has been put forward and fairly generally accepted to account at least for


Freshly drawn heparinised blood (about 30 ml.)
10 ml. centrifuged for 5 to 10 min.
Cells
Plasma
Treated with about 250μC 32P in isotonic saline, incubated for two hours at 37° with occasional mixing. Cells spun down and washed 4× with 5 vol. saline and then suspended in an equal vol. saline or original plasma
1·0 ml. labelled cell suspension diluted to 100 ml. in distilled water (containing carrier phosphate) to give solution S1.
10 ml. S1 diluted to 100 ml. with 50 per cent. "teepol" to give solution S2.
5·0 ml. labelled cell suspension injected. Heparinised blood sample (about 20 ml.) taken 15 min. after injection.
In duplicate
9·0 ml. blood + 1·0 ml. 50 per cent. "teepol."
10 ml. lysed blood samples for counting in M6 counter (activity CT).
In duplicate
9·0 ml. blood + 1·0 ml. S2.
10 ml. standard for counting in M6 counter (activity CS).

Calculation

$$\text{Blood volume} = V \times \frac{C_1}{C_2}$$ where V = vol. of cell suspension injected,

C_1 = radioactivity/ml. of injected cell suspension, and

C_2 = radioactivity/ml. of 15 min. blood sample.

In the above example $C_1 = C_S \times \frac{10{,}000}{10}$

$$C_2 = C_T^* \times \frac{10}{9}$$

$$V = 5 \text{ ml.}$$

*Corrected for *in vivo* loss of ^{32}P.

FIG. 8.—Scheme for blood volume determination on horse.

part of this discrepancy, is that the distribution of cells and plasma is not the same throughout the body. If this is the case one way of getting a figure approximating to a true blood volume would be to make simultaneous measurements of red cell volume and plasma volume. This is, of course, time consuming, and there has naturally been a good deal of work in trying to establish a relationship between the true blood volume and what one measures with either a red cell volume or plasma volume method. So far these studies have been confined almost exclusively to man and the common laboratory animals.

The relationships are as follows,

$$BV = Vc + Vp$$

where BV = true blood volume, Vc = red cell volume and Vp = plasma volume. If labelled cells give a true estimate of the red cell volume, and labelled plasma protein a true estimate of plasma volume, then BV will represent the true blood volume of the animal. The blood volume measured with labelled cells (BVc) is usually smaller than BV, and the

blood volume measured with labelled plasma protein (BVp) is usually larger than BV. BVc and BVp are related to Vc and Vp respectively as follows,

$$BVc = \frac{Vc \times 100}{Ht} \text{ and } BVp = \frac{Vp \times 100}{(100 - Ht)}$$

where Ht = percentage of cells in peripheral blood, *i.e.*, haematocrit corrected for trapped plasma. In trying to establish a relationship between BVc and BV or between BVp and BV it is important that Ht should be measured correctly. The magnitude of the correction applied to the measured haematocrit for plasma trapped in the red cell column is still a matter of some dispute. So far most of the determinations have been made on human blood and correction factors varying from 2 to about 12 per cent. have been proposed by different workers. For a survey of the results and methods see Vasquez, Newerly, Yalow & Berson (1952), also McLain & Ruhe (1949).

From a technical point of view one of the most satisfactory determinations of trapped plasma has been carried out by Leeson & Reeve (1951). These workers obtained a figure of 4 to 5 per cent. for human, dog and rabbit blood. The method employed was the addition of serum albumin, trace-labelled with ^{131}I, to the blood before centrifuging, and then after centrifugation, radioactivity determinations were carried out on the packed cells and supernatant. We are using an essentially similar method in our investigations on the domestic animals. The principle is demonstrated in Fig. 9.

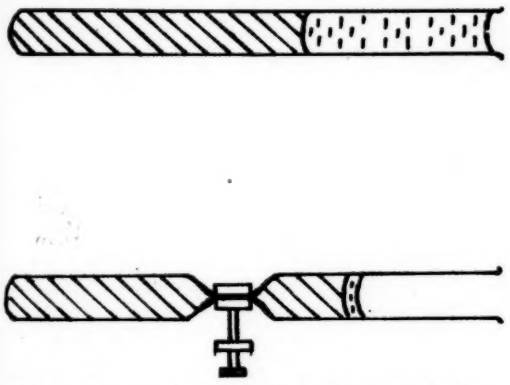


Fig. 9.—Separation of packed cells from plasma.

The blood sample is treated with a small volume of radio-active homologous serum albumin, mixed thoroughly and centrifuged under standard conditions, *i.e.*, 30 minutes at an R.C.F. value of 1,500 g. (See Gregerson, 1951.) In removing samples of packed cells and plasma for radioactivity determination, it is essential to avoid contamination of the packed cells with plasma. To overcome this we have adopted a technique originally described by Randolph & Ryan (1950) for separating packed cells and plasma, *i.e.*, centrifuging in a polythene tube which is then clamped some distance below the top of the cell column as shown in Fig. 9. The tube is cut off above the clamp leaving packed cells.

So far we have determined the percentage of trapped plasma in rabbit, dog, horse and bovine blood (Table II). Our results for rabbit, horse and dog are of the same order but rather lower than those of Leeson & Reeve. The correction for bovine blood is much larger and as can be seen by the S.D. is also more variable. It seems likely, therefore, that centrifugation for a longer time and/or at a higher R.C.F. will be necessary to get complete packing of bovine red cells

Table II
Haematocrit Corrections

Species	No. of determinations	% of trapped plasma
Rabbit	22	3·3 ± 0·47
Dog	10	3·1 ± 0·26
Horse	32	2·9 ± 0·67
Bovine	22	12·5 ± 4·84

and thus a correction factor for trapped plasma of the same order as is used in other animals. It must be pointed out that, since the R.C.F. value at any point on the cell column depends on the distance from the centre of the centrifuge head, differences in packing may be expected at different points on the cell column. This may lead to variations in the percentage of trapped plasma with blood samples of different haematocrit, but these variations are likely to be too small to be of practical importance.

We have carried out a preliminary experiment with rabbits on the simultaneous determination of blood volumes with labelled cells and labelled plasma. There are obvious sources of error in making such determinations, *viz.*, ^{32}P diffusing from the cells and interfering with the ^{131}I measurements on the plasma, or plasma (^{131}I) adhering to, or being trapped by, the cells and so interfering with the ^{32}P measurements. We feel that these two sources of error can be largely overcome by (*a*) precipitating the plasma proteins prior to ^{131}I determination and (*b*) using a counter for the ^{32}P measurement which is relatively insensitive to ^{131}I. The method used, incorporating these techniques, will be described in detail elsewhere.

The results of a preliminary experiment on rabbits are shown in Table III. In all cases BVc is significantly lower TAKE IN TABLE III—— and BVp significantly higher than the true blood volume (Vc + Vp). The percentage of cells in total blood $\left(\frac{Vc \times 100}{Vc + Vp}\right)$, *i.e.*, the body Ht, is in all cases significantly smaller than the percentage of cells in peripheral blood (Ht). It is possible using the average value of $\frac{Ht}{\text{Body Ht}}$ to apply a correction to BVc or BVp which should give a figure approximating to the true blood volume BV.

$BV = Vc + Vp$ Let $BV = f_1\ BVc$ where f_1 is a correction factor relating BV and BVc.

$$\text{Now } BV = f_1\left(\frac{Vc \times 100}{Ht}\right)$$

$$f_1 = \left(\frac{Vc + Vp}{Vc \times 100}\right) Ht$$

$$f_1 = \frac{Ht}{\text{Body Ht}}$$

The figures in the last column of Table III were obtained by correcting the values for BVc using the mean value for f_1. The agreement between these figures and the values for BV is generally good. Although we do not suggest that a determination on four rabbits is adequate to determine a completely representative figure for f_1 the results so far seem promising.

We propose to carry out simultaneous determinations with labelled cells and labelled plasma on the various domestic animals and so determine conversion factors in each case. The problem is of practical as well as theoretical importance. In the case of the bigger animals ^{32}P labelling of cells would seem to provide the cheapest and least hazardous isotopic

Table III
Simultaneous Determinations on Rabbits with ^{32}P-Labelled Cells and ^{131}I-Labelled Serum Protein

Rabbit No.	Vc (^{32}P)	Vp (^{131}I)	Vc + Vp (True BV)	BVc (^{32}P)	BVp (^{131}I)	$\frac{Vc \times 100}{Vc + Vp}$ (Body Ht)	Ht	$\frac{Ht}{Body\ Ht}$ f_1	Blood volume calculated from BVc and mean value for f_1
1	37·5	56·2	93·7	81·6	104·3	40·0	46·1	1·15	95·5
2	49·5	87·4	136·9	116·0	152·2	36·2	42·7	1·18	135·8
3	37·3	87·9	125·2	111·4	132·2	29·8	33·5	1·12	130·3
4	59·0	109·2	168·2	138·8	189·8	35·1	42·5	1·21	162·4
								mean = 1·17	

The figures given are for the total blood volumes of the animals.

method of measuring blood volumes, and thus it would be desirable to be able to correct the figures obtained by this method to get a figure which corresponds more closely to the true blood volume.

The Anaemia Produced by Infection with *F. hepatica*

The techniques of labelling red cells with ^{32}P and plasma proteins with ^{131}I, which have been described above, have been utilised to study the anaemia produced by the liver fluke *F. hepatica*. This anaemia, which is a characteristic feature of chronic fascioliasis in sheep and cattle, is usually ascribed to the production of a haemolytic toxin by the parasites (see reviews by Cameron, 1951 ; and Mönnig, 1950), although Stephenson (1947) in a study of the feeding habits of *F. hepatica* concluded that they live almost entirely on blood. Investigations on the anaemia produced experimentally in rabbits infected with *F. hepatica* showed that it could be ascribed entirely to haemorrhage produced by the parasites in the bile ducts (Urquhart, 1954). As additional confirmation of this work, and in an attempt to find the rate of blood loss per fluke, it was decided to label the red cells or plasma proteins of infected and normal rabbits, and after an interval to measure the radioactivity in the bile and in the parasites.

Some experiments of this nature have been carried out in which a suspension of homologous labelled red cells was injected into the infected animals and into an equal number of non-infected rabbits. One hour after injection the rabbits were killed and the bile and flukes analysed for radioactivity. The flukes and bile obtained from the infected rabbits were markedly radioactive ; the radioactivity of the bile from the control rabbits was, by comparison, negligible. By comparing the radioactivity of the flukes and bile with that of the blood in the case of each rabbit, it was possible to calculate the blood loss in one hour and hence the blood loss per day.

Table IV
Calculated Blood Loss of Infected Rabbits

Rabbit No.	Method	No. of flukes	Est. blood loss in 24 hours (ml.)	Blood loss per mg. fluke N in 24 hours (ml.)
X	^{32}P cells	6	0·67	0·024
9	"	25	4·80	0·024
0	"	18	2·60	0·017
I	"	25	4·82	0·026
Z	"	34	7·60	0·031
10	"	13	7·70	—
0703	"	20	4·20	—
5	"	7	3·30	—
1	^{131}I – serum protein	32	3·86	—
13	"	20	2·10	—

Average loss per fluke = 0·2 ml. in blood 24 hours.

Table IV shows the results obtained from eight infected rabbits. Although there is a fair degree of correlation between the numbers of flukes and the amount of blood lost, it does not apply in all cases. This may be due to the activities of the flukes at the time of the experiment or to variations in the size of the flukes. This latter factor may be quite considerable and in order to correct for this the blood loss in later experiments was expressed per mg. of fluke nitrogen (column 5, Table IV).

Two preliminary experiments have been carried out using serum proteins labelled with ^{131}I (see Table IV) and the figures obtained for blood loss are comparable to those given by the labelled red cell method.

A possible criticism of these experiments is that the excess radioactivity found in the flukes and in the bile of infected rabbits might be due to a pathological increase in the biliary excretion of breakdown products of either the red cell or serum proteins. We think this criticism is theoretical rather than practical but we hope, in the near future, to repeat these experiments using labelled red cells and labelled serum proteins simultaneously in the *same* rabbit, and to confirm our findings further.

In Table IV figures are given for the estimated blood loss which varied from 0·67 to 7·7 ml. over 24 hours in different rabbits. The red cell counts of these infected rabbits were 2·5 to 4·5 million R.B.C. per cu. mm., the degree of anaemia being proportional to the number of flukes present. That this degree of daily blood loss is sufficient to produce such low red cell counts is substantiated by the work of Oberg (1949), who removed 3 to 6 ml. of blood daily from rabbits over a period of several months with the production of red cell counts similar in order to those obtained in our experimental rabbits.

Conclusion

These isotopic methods have been in use at the Glasgow School for rather less than a year, but already we feel justified in some degree of optimism about the future of these techniques in the study of problems connected with animal health and disease. In the near future an isotope department will be considered an indispensable unit in human hospitals, and there is every reason to believe that animal hospitals and veterinary research establishments will be able to utilise tracer methods to at least as great an extent.

Acknowledgments.—This work was supported partly by a grant from the Agricultural Research Council, and partly by a grant from the Racecourse Totalisator Charities Trust.

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THE FOURTH STUDY MEETING OF THE EUROPEAN ASSOCIATION FOR ANIMAL PRODUCTION

After the success of its Third Study Meeting (Siena-Italy, September, 1953), where the problems of meat production in Europe were treated, the E.A.A.P. has arranged to hold the Fourth Study Meeting in Lucerne (Switzerland).

The meeting will be dedicated to the study of the influence of climate on animal production. The programme includes three general conferences in which three aspects of the problem will be examined: the influence of tropical and subtropical climate, of cold climate, and of climate in high altitudes. The question of keeping livestock in open sheds under low temperature conditions will also be discussed. The programme contains numerous excursions to visit some regions of the Alpine zone in Switzerland. This will give an opportunity to discuss the subjects treated by the conferences during practical field demonstrations. A definitive programme will soon be published by the Swiss Society for Animal Production, which is charged with the organisation.

The Study Meeting, which will be held from September 25th to October 2nd, 1954, will coincide with the 11th Swiss Agricultural Exhibition and will enable the European specialists to study a problem which has not been discussed very often on our continent. It is hoped that these discussions will encourage the undertaking of some new research work in this very interesting field.

For further information correspondence should be addressed to the Secretariat of the Study Meeting, Swiss Society for Animal Production, Verbandshaus, Zug, or to the Secretariat of the European Association for Animal Production, Via Quintino Sella, 54, Roma.

SUDDEN DEATH OF CATTLE ATTRIBUTED TO PERACUTE HYPOMAGNESAEMIA

BY
G. S. GRATER, A. D. OSBORNE AND J. B. WHITE,
SALISBURY

The clinical syndrome in acute hypomagnesaemia is well recognised and an accurate diagnosis of the disease can readily be made without the confirmation of the results of blood analysis. But in some outbreaks the clinical picture is rather puzzling, especially those in which sudden death is a feature. Such an example is discussed in this account of the disease as it affected a herd in Wiltshire, illustrating how easy it is to overlook its occurrence.

The disease occurred in July, 1953, in an Ayrshire herd which had recently moved from a farm on heavy clay soil at Westbury, Wiltshire, to one on light chalk on Salisbury Plain. The cows had been on pasture on the old farm, and following their removal on June 24th to the new farm had grazed the same three fields, which were all of a permanent type of pasture with a moderate admixture of clover.

Three cases occurred within 10 days, all of which were cows which had calved less than two months. The first (A) was seen drinking at a water trough, it then staggered a few feet and died immediately. The second (B) was found dead in the early morning without a history of ill-health, and the third (C) also died during the night after milking normally the previous evening. The characteristic feature of the disease was therefore its sudden onset and rapid course. Anthrax was excluded as a possible cause, and a diagnosis of hypomagnesaemia was made on the low blood magnesium values found in samples from two out of six cows maintained under the same conditions, but being at a much more advanced stage of lactation than the three which died. The actual figures for the six cows were:—

	Favourite	Besta	Beauty	Laura	Lusty	May
Calcium mg. p.c. serum	10·7	10·4	10·0	10·0	9·3	10·5
Magnesium mg. p.c. serum	2·5	2·0	1·6	2·3	1·8	2·0
Acetone mg. p.c. serum	Normal					

PATHOLOGICAL DATA

Post-mortem examinations were made on all three animals and the most striking features were as follows. In the case of Cow A, the spleen was enlarged and had ruptured with extensive haemorrhage into the abdominal cavity. The findings were similar in Cow B and there was acute congestion of the abomasum. Cow C also showed enlargement and rupture of the spleen and the abdominal cavity contained approximately half gallon of dark blood-stained fluid. There were haemorrhages into the peritoneal surface of the abdominal viscera, into the abomasal and small intestinal mucosa, though these were most striking in the muscular portion of the diaphragm. In the chest cavity there was evidence of haemorrhage, estimated at between one to two gallons of blood and there were well-marked endocardial haemorrhages.

A cultural examination of the viscera failed to reveal any significant infection, and a search of the ingesta did not yield any poisonous plants. Histological examination of the spleen revealed extensive congestion and there was considerable deposition of iron compounds.

Discussion

Although relatively sudden death is not uncommon in acute hypomagnesaemia, there is usually a history of typical cases occurring on the farm. In this instance this was not the case and other possible causes of death might rightly be implicated. Furthermore, the consistency of splenic rupture was a feature which could be taken as an indication of some other condition. However, the pathological findings were consistent with those recorded for acute hypomagnesaemia and the fact that they were more intense might be accounted for by the peracute nature of the disease. Infection was excluded, there was no evidence of the common plant poisons, and lead poisoning was excluded by analysis carried out at Weybridge. All the features, including the finding of low blood magnesium values in in-contact cows were strongly indicative of hypomagnesaemia. The survivors were fed a magnesite supplement and the disease did not recur.

Acknowledgments.—We are indebted to Dr. R. Allcroft for analysis of the kidney of one animal and the blood samples from six of the survivors.

REVIEW

[**Beef Production.** M. M. Cooper. Pp. 234. Thomas Nelson & Sons Ltd., Edinburgh. Price 12s. 6d.]

" Beef Production " by Professor Cooper, of Wye College, is a comprehensive survey of the pre-war industry, the impact of war and post-war agricultural policies, and his ideas of what future policy should be.

He discusses the development of British beef breeds from the time of Bakewell, the mechanism of inheritance and of selection, and the requirements of progeny testing and its value in breeding.

The book deals concisely with methods of breeding and selection, with the scientific principles of nutrition, and feeding standards. He deals with the problems of the industry in full detail and his measures for the future make very interesting reading and indicate the need for higher efficiency in milk production, in grassland management and a changeover from the rigid conservation of beef breeds to an acceptance of beef from dairy herds as part of future policy.

He calls for a marketing policy to enable the industry to organise itself and to instil confidence into the farmer—which will assuredly command the ear of the N.F.U.—and the need for refrigeration to deal with seasonal gluts of home-produced meat.

There is so much in this book of interest to the veterinary surgeon—so much of hard headed fact and thinking—that it can well be recommended to all in agricultural practice.

HUMAN INFECTIONS FROM ANIMALS

The United Nations World Health Organisation has reported that more than 80 diseases can be transmitted to human beings by domestic or wild animals. Dogs may cause 27 of these diseases and cats 14. Fifteen of these diseases are found in Europe. These include bovine tuberculosis, undulant fever, marsh fever and rabies. Pigs, horses and dogs are the chief carriers of the sometimes fatal marsh fever. The infection may be transmitted through stagnant water, even water in swimming pools, and sometimes the disease is likely to thrive in establishments where food is stored unless sanitary precautions are observed.

Most of the diseases transmitted to human beings by animals, add the organisation, could be eradicated if Governments adopted on an increasing scale animal disease control programmes.

CLINICAL COMMUNICATION

POST-OESTRUAL PROLAPSE OF THE VAGINA AND UTERUS IN THE GILT

R. H. C. PENNY,
Leighton Buzzard,
and
G. H. ARTHUR,
Royal Veterinary College, Streatley

Increased vascularity and swelling of the genital tract during oestrus are common to all the domesticated animals, and in the vulva of the sow and gilt constitute the most obvious sign of heat. Similar, but more marked, changes are seen when there is hormonal imbalance—with an increased blood oestrogen level—as in bovine nymphomania and when there has been artificial administration of oestrogenic compounds, or actual ingestion of naturally occurring oestrogens in food.

In the causation of the familiar late gestational vaginal prolapse of the cow, hormonal factors have not been invoked but attention has been directed to such factors as increasing abdominal tension, gravity, fatness and insecure attachment of the genital tract. However, in the sheep Bennetts *et. al.* (1946) have described uterine prolapse which sometimes occurred in young unbred animals grazing on pastures of subterranean clover containing a high oestrogen content. Also, in the larger breeds of bitch, prolapse of the vagina during heat has been seen. The purpose of this report is to put on record a condition, not hitherto described, of prolapse of the vagina in the post-oestrual gilt.

Up to the present, only animals of the Large White breed have been affected. In all cases oestrus had occurred during the previous few days. It is believed that the oedematous swelling of heat predisposes to the condition, and that the irritation, and possibly injury, of service is an exciting factor in some cases. In others, coital mimicry may initiate the eversion.

The subject is remarkably indifferent to the affection, but the protruded viscus is prone to suffer fissures from the venous congestion and swelling, coupled with the drying which takes place. If in the company of other animals, there is a real danger of savaging with consequent laceration, haemorrhage and shock.

In diagnosis, care must be taken to differentiate the condition from rectal prolapse and intestinal invagination, and this entails a close and thorough examination. The prolapsed vagina may obscure the anus, and the folds and crevices which develop in it cause a similar appearance to prolapse of the rectum.

The prognosis varies with the degree and duration of the prolapse, and with the severity of any damage sustained. Early cases have been treated successfully by pressure with warm moist swabs together with parenteral injections of penicillin. Where there has been more delay before veterinary attention is sought, it may be impossible to replace, or to cause retention of, the replaced organ, and in these cases the operation of submucous resection is indicated. In a recently observed case the vaginal prolapse had suffered a complete laceration and in the lumen of the prolapsus a length of uterine horn was directly visible. Here, in view of the potential breeding value of the animal, it was decided to attempt reposition of the uterus by peri-

tonceal taxis and to retain it by ventrifixation, at the same time suturing the rent in the vagina from outside. The details were as follows:—

Subject.—A pedigree Large White gilt aged 11 months and of estimated value £200.

History.—It was reported in the morning that one of a group of gilts had a "large prolapse of the bowel which was not present the previous evening." Advice was given to isolate the animal and to bathe the affected part with warm water. When seen that evening a prolapse of the vagina was diagnosed, the extruded part being the size of a large coco-nut. It was arranged to operate on the following morning by which time a complete rupture of the vagina had occurred with protrusion of a uterine horn. The gilt was bright and active and took food.

Operation.—It was anaesthetised with pentobarbital sodium (nembutal) via the marginal ear vein. An initial injection of 20 c.c. was administered quickly and followed by a further 15 c.c. given more slowly. The abdominal incision was made parallel with, and lateral to, the left mammary glands. It began just in front of the fold of the flank and extended forwards for 8 inches. There was a considerable depth of fat in the subcutaneous and subserous layers. The peritoneal cavity contained several ounces of fluid and yellow flocculent masses. The left hand was passed through the incision and the uterus sought. At this stage the gilt moved its limbs and a further volume of 15 c.c. of nembutal was injected intravenously over a period in order to restore and maintain surgical anaesthesia. The left uterine horn was normally disposed but only the anterior third of the right cornu was palpable as the remainder had become invaginated through the short uterine body, cervix and vagina, and this, undoubtedly, was the viscus which was visible externally through the lacerated and prolapsed vagina.

Efforts were now made to reduce the intussusception by drawing forward on the right cornu from within the abdominal cavity and repelling the everted part. After a considerable trial these were unsuccessful, and even introduction of the right hand and direct pressure on the intussuscipiens failed to reduce the uterine invagination. The failure was believed to be due to the amount of swelling which had occurred in the intussusceptum.

Extravaginal amputation was next considered, but since the gilt was required for breeding this would have been pointless, and it was therefore decided to salvage the animal on the following day (Monday). Accordingly the abdominal incision was repaired using No. 4 plain catgut for peritoneum, fat and muscles, and nylon for the skin. Prior to closure of the peritoneum 1,000,000 units of penicillin in solution were sprayed into it and a similar dose given subcutaneously. Surgical interference finished at noon and on the following morning the gilt had recovered completely from the anaesthetic and took food. In the afternoon she walked to a wagon and was loaded for slaughter. With the exception of an area around the laparotomy wound the carcase passed for human consumption.

Comment

There is little doubt that once the uterus has passed into the vaginal prolapse, reduction by extra vulvar manipulations will be impossible, for it must be remembered that in the non-parturient gilt it is quite impossible to pass the hand into the vagina. Apart from the intrinsic gynaecological interest of this case the writers have been impressed by the convenience and safety of pentobarbital sodium as a general anaesthetic, even for the large pig, and with the tolerance of the pig to peritoneal manipulation. It is suggested that a similar operation, if carried out in good time, might, when combined with retropulsion *per vaginam*, constitute a satisfactory treatment for post-parturient uterine prolapse in the sow.

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ABSTRACTS

White Muscle Disease (Muscular Dystrophy)*

This is a general article based on Canadian experience. In Schofield's experience at least two factors are important in causation, namely, phosphoric acid and vitamin E deficiency. Certain predisposing factors are also important, such as sudden exercise occurring after long periods of winter housing, poor quality food, and exclusive milk feeding. The relative frequency of the disease in beef herds is stressed as compared to dairy herds.

It is pointed out that clinically the acute form may be mistaken for acute pneumonia, and subacute cases may resemble arthritis.

The treatment for lambs of about one month old should be 20 ml. of dilute phosphoric acid daily for one week, and 250 to 500 mg. alpha tocopherol daily for three days, and half the dose for the next three days. The same treatments proportionately increased are employed in calves.

D. L. H.

* **The Prevention and Treatment of White Muscle Disease (Muscular Dystrophy).** Schofield, F. W. (1953). *Canad. J. comp. Med.* **17.** 422–424.

* * * * *

The Pathology of Hypovitaminosis A in Calves*

The authors briefly reviewed the literature on the subject of avitaminosis A. They then carried out a series of experiments in calves in order to determine the clinical symptoms, the spinal fluid pressures, the histopathological changes and to assay the blood plasma and liver levels of vitamin A and carotene.

The calves were divided into groups and fed carefully controlled diets. Diarrhoea and inco-ordination were consistent aspects of vitamin A deficiency. Cerebrospinal fluid pressure rose from about 95 to over 178 mm. and in some instances to over 505 mm. Histological examinations showed squamous metaplasia of the interlobular ducts and the main duct of the parotid gland. This was regarded as pathognomonic. Focal hepatic necrosis was seen in some cases. The crude data suggested that depleted calves were more susceptible to pneumonia than were the supplemented animals but "treatment of the data by the chi square method failed to reveal any significant relationship."

Carotene failed to reverse the pathognomonic lesions of the parotid gland although it did ameliorate the diarrhoea and inco-ordination. Vitamin A feeding for two weeks produced partial reversal of the squamous metaplasia and feeding for four weeks brought about complete recovery.

A. R. J.

* **The Pathology of Experimental Hypovitaminosis A in Young Dairy Animals.** Helmboldt, C. F., *et al.* (1953). *Amer. J. vet. Res.* **14.** 343.

Muscular Degeneration in Pigs*

"Muscular degeneration" (MD) is described as a condition in pigs in which the affected musculature appears pale or greyish in colour, is very juicy, and has a strong sour odour. Total MD, in which all the muscles are affected, is less commonly seen than the transitional form in which one or several groups of muscles are affected. The affected muscle, shortly after slaughter, has a higher temperature and a lower *p*H than normal. On standing in a tray, MD pork will yield 10 per cent. of its weight of fluid, and under pressure may yield 20 to 30 per cent. Histologically, the affected muscles show interstitial oedema, and a loss of transverse striations; in fatal cases there is hyaline degeneration and commencing necrosis. In the muscle there is increased urea-N and less coagulable protein-N.

The disease can be diagnosed definitely only on *post-mortem* examination. There are no specific symptoms, although affected animals may show lethargy, a rise in temperature, dyspnoea, a slight cyanosis, muscular twitches and muscular weakness. The disease often ends fatally, and fatal cases show pathological changes similar to those seen in the acute "Herztod" described by German authors. Forced muscular activity related to transport to the slaughterhouse, and excitement on arrival, appear to play a part in the outbreak of MD, and if the pigs are rested for 18 to 24 hours before slaughter a reduction in the number of cases of MD occurs. Blood examinations suggest changes in electrolytic balance predisposing to shock, and, further, there are indications that a diminished thyroid function is concerned in the pathogenesis of the condition because it has a seasonal incidence, with more cases in the summer; it has been produced experimentally by blocking the activity of the thyroid gland with methylthiouracil and clinical cases (diagnosed with the aid of muscle biopsy) have been treated successfully with iodinated casein.

E. C.

* **Muscular Degeneration in Hogs.** Ludvigsen, J. (1953). *Proc. Pt. I Int. Vet. Congr., Stockholm.* **1.** 602–606.

SCIENTIFIC RESEARCH IN PAKISTAN

The Government of Pakistan has paid close attention to the need for planning scientific research organisations, and provision has been made, or is planned, for research in agriculture, medicine, industry and engineering. The Food and Agriculture Council, inaugurated by the Pakistan Prime Minister on July 2nd, 1953, has been set up to promote and co-ordinate scientific and technological research relating to agriculture, animal husbandry and fisheries, and to enable full advantage to be taken of the results of this research. The members of the Council are officials of the Central and State Governments and representatives of producer interests. There is as yet no central research organisation for agriculture, although there is an Animal Husbandry Research Institute, and most of the actual work of research is done in the Provinces and States and at universities, the Council helping with finance.

Governmental attention has also been given to tackling the locust menace. A Locust Control Committee set up in 1950, which has initiated research into locust control with particular emphasis on control of flying swarms, made the discovery—described by Lord Boyd Orr as of "far-reaching importance," and as one which would "earn the gratitude of all those who have to control agricultural pests in many countries of the world"—that water, instead of the expensive oil used hitherto, could be used as a carrier in aerial spraying operations. This had previously been considered impossible.

REPORT

Annual Report of the Veterinary Department of Nigeria, 1951-52

This Report should more correctly be entitled the Annual Report of the Inspector-General of Animal Health Services, for during the year the three field sections—Northern Region, Western Region and Eastern Region—have each acquired complete autonomy under a Director of Veterinary Services or equivalent rank.

Only the departmental sections of Research, Production of Biologicals, Education and Hides and Skins Improvement remain under the direction of the Inspector-General.

It is pleasing to note that in the opinion of the Inspector-General the new administrative set-up has, on the whole, worked well. All the same, it is difficult to see how such a departmental dismemberment, whereby the Colony is divided up into three water-tight compartments, each separate and completely divorced from Headquarters and the Research Division except through a tenuous association with the Inspector-General, can prove the ideal organisation to secure an effective control over disease and uniformity in livestock development.

The Central Minister of Natural Resources, The Hon. Muhammadu Ribadu, M.B.E., in a foreword to this Report, has drawn attention to an increase in the number of outbreaks of rinderpest occurring during the year and a fall in the number of animals immunised.

These facts are often not disassociated and the situation may be due to a too premature complacency on the part of native stock owners because of the more satisfactory disease position arising from the vast immunisation campaign of past years.

Caprinised virus vaccine has continued to be used in the immunisation of adult Zebu cattle in the Northern Provinces and the production and issue of the vaccine has exceeded the figures of any previous year.

The vaccine has, on the whole, continued to give satisfactory results. On two occasions when the cause of a higher than normal mortality following vaccination was investigated the cause was found to be mainly secondary factors such as malnutrition, helminthiasis, trypanosomiasis, babesiosis and coccidiosis.

The attainable goal of an Africa freed from the scourge of rinderpest is still not in sight. And it will require a pan-African approach with a more centralised executive authority and not a continuance of water-tight areas each dealing with the disease according to political and economic expediency before this momentous achievement can be realised.

The Inspector-General writes that contagious bovine pleuro-pneumonia continues to cause grave concern, and in spite of determined efforts to effect control the incidence is still extremely high.

The true incidence of the disease remains largely obscure because of the general reluctance of native stock owners to report outbreaks. Only a vigorous and widespread campaign of immunisation with a safe and efficient vaccine will meet the problem of control of this insidious and grave menace to progressive livestock development. To the discovery of such a vaccine the available resources of every centralised laboratory in Africa should be dedicated.

Trypanosomiasis also is still a major disease problem. The demand for curative treatment with antrycide methyl sulphate far exceeds the available supplies of the drug. The value of this drug as a prophylactic for trade cattle was amply demonstrated by experiment, but further experiment is considered necessary before the use of the drug in breeding herds can be authorised. "Other epizootic diseases of cattle have been kept under control by the usual prophylactic measures."

Animal clinics continue to function throughout the country with growing efficiency and to render valuable and appreciated service.

Livestock Industries

The price of slaughter stock has shown a steady rise, and the dried meat trade continues to flourish. The use of humane killers for horse slaughter by trained men continues to make steady progress in the Eastern Region. This is an improvement which public clamour has been demanding for years. The use of humane killers will do away with the savagery which so often attended the ritual of horse slaughter in this region.

The Food Production scheme run by the department with conspicuous success since 1939 has been wound up.

Hides and Skins

World prices for hides and skins slumped badly during the year and if Nigerian products are to maintain their position in a highly competitive market the scheme for improved production must be extended and rigorously enforced.

No longer can quantity be the chief objective, as it was during the war, and every effort must now be made to eliminate all factors detrimental to first-quality production. The appointment to the vacant post of Principal Hides and Skins Improvement Officer is a matter of supreme importance and urgency.

Livestock Improvement

The five livestock investigation centres established by the department under the Development Plan all continue to make steady progress.

A scheme has been started to inseminate Zebu cows at Vom with imported semen to produce grade animals for use in closed urban dairies. A reasonable proportion of the cows are known to be in calf.

Research

Mr. A. L. C. Thorne, Assistant Director of Laboratory Services (Acting), has submitted a report on the work of the Veterinary Laboratory.

A total of 4,026,908 doses of the different vaccines was issued from the laboratory during the year.

The use of lapinised virus vaccine has been extended in the Western Region, where because of the high susceptibility of the indigenous cattle to rinderpest caprinised virus cannot be used.

Contagious Bovine Pleuro-pneumonia

Preliminary investigations were carried out into the possibility of obtaining a cheap antigen by means of chemical precipitation of broth cultures with the object of supplying a simple and reliable diagnostic test for field use. Early results are encouraging. Investigations were carried out also into anthrax, fowl typhoid, brucellosis and skin diseases of cattle.

Nutrition

Feeding trials were carried out to ascertain the value of red palm oil as a substitute for cod-liver oil in poultry nutrition and the benefits from replacing one-third of the vegetable protein in the ration with animal protein. The addition of meat brought about accelerated growth, especially in the early stages of life. The carotene content of red palm oil proved a satisfactory source of vitamin A for growth.

The vitamin A content of the livers of two cockerels which had received palm oil considerably exceeded that of cockerels fed on cod-liver oil. Red palm oil, while proving an ample substitute for cod-liver oil, is likely to be free of any undesirable antivitamin effects.

Veterinary Education

A report by the Principal (Mr. G. Williamson, O.B.E., F.R.C.V.S.) gives an account of the work of the Vom Veterinary School.

The school continues to function as an important part of the activities of the department. There African assistants are trained for the many subsidiary duties which, for economic and other reasons, could not under Nigerian conditions be performed by European staff.

Mr. R. S. Marshall, M.R.C.V.S., D.V.S.M., DIP. BACT., the newly appointed and first holder of the post of Inspector-General of Animal Health Services, is a man of long and varied experience in Africa. On him rests a big responsibility to see that under the new administrative set-up the veterinary services of Nigeria continue to play their vital part in bringing the livestock industry to full development and production.

W. W. H.

QUESTIONS IN PARLIAMENT

HUMAN INFECTION WITH FOWL PEST

Mr. BULLARD (March 4th) asked the Minister of Health if his attention has been drawn to the danger that four men in Norfolk may have contracted fowl pest after helping with the slaughter of chickens among which the disease had broken out; and if he will make a statement.

Miss HORNSBY-SMITH: My right hon. Friend is advised that this disease, although in a limited sense transmissible to man, is not readily passed on among human beings. The only known clinical form of the disease in man is a mild inflammation of the eyes without constitutional disturbance. In the instance referred to the men are now back at work.

Mr. BULLARD: Does the Parliamentary Secretary appreciate that the policy of the Minister of Agriculture towards this disease is very drastic, being one of slaughter and compensation? I do not want her to pursue such a drastic policy towards human beings, but would she take an opportunity to make it quite clear to farmers and farmworkers how great or how small the risk may be?

Miss HORNSBY-SMITH: I think it might reassure my hon. Friend if I told him that, while it is not unreasonable to attribute the eye condition in the two men concerned to contact at work with the diseased fowls, the laboratory tests which were made did not confirm this association.

NOTES AND NEWS

Diary of Events

Mar. 17th.—Laboratory Meeting of the Royal Society of Medicine, Section of Comparative Medicine at the Royal Veterinary College, N.W.1, 4.30 p.m.

Mar. 17th.—Ordinary Meeting of the Microscopical Society at Tavistock House South, Tavistock Square, W.C.1, 5.30 p.m.

Mar. 18th.—Annual Dinner and Dance of the East Midlands Division, B.V.A., at the George Hotel, Nottingham, 7.15 p.m.

Mar. 18th.—Meeting of the Ayrshire Division, B.V.A., at the Hotel Dalblair, Ayr, 2.30 p.m.

Mar. 18th.—General Meeting of the Herts and Beds Division, B.V.A., at the Red Lion Hotel, Luton, 7.30 p.m.

Mar. 19th.—Annual General Meeting of the South Wales Division, B.V.A., at the Royal Mount Ephraim Hotel, Tunbridge Wells, 2 p.m.

Mar. 20th.—Annual General Meeting of the Biochemical Society in the Department of Chemistry, University College, Gower Street, London, W.C.1, 10.45 a.m.

Mar. 24th.—Meeting of the North Wales Division, B.V.A., at the Council Chambers, Ruthin, 2 p.m.

Mar. 25th.—V.V.B.F. Ladies' Guild: North of Scotland Division, B.V.A., Annual Dance, Aberdeen.

Mar. 25th.—Annual General Meeting of the Western Counties Division, B.V.A., at the Imperial Hotel, Exeter, 11 a.m.

Mar. 25th.—Spring Meeting of the North of Scotland Division, B.V.A., in the Northern Hotel, Aberdeen, 2.30 p.m.

Mar. 26th.—Annual Dinner and Dance of the Yorkshire Division, B.V.A., at the Parkway Rooms, South side entrance to the Parkway Hotel, Bramhope, Leeds, 7 p.m.

Mar. 31st.—Meeting of the Technical Development Sub-committee on the Calf Report, 7, Mansfield Street, W.1, 11 a.m.

Apr. 1st.—Meeting of the Technical Development Committee, B.V.A., at 7, Mansfield Street, W.1, 10.30 a.m.

Apr. 2nd.—Joint Ordinary General Meeting of the A.V.T. and R.W. at the Royal Veterinary College, Camden Town, N.W.1, 10 a.m.

Apr. 3rd.—Annual Dinner of the B.R.X. Club at the Royal Veterinary College, Camden Town, N.W.1, 6 p.m.

Apr. 10th.—Reunion Dinner of the R.V.C. '52 Club at "Ye Miller of Mansfield," Streatley, 7.30 p.m.

Sept. 19th—25th.—72nd Annual General Meeting and Congress of the British Veterinary Association at Torquay.

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B.V.A. Council and Committee Meetings at the University of Glasgow

Monday, April 12th

10.30 a.m. Veterinary State Medicine Committee.
2.15 p.m. Home Appointments Committee.
3.30 p.m. Parliamentary and Public Relations Committee.

Tuesday, April 13th

10.30 a.m. Organising Committee.
1.45 p.m. General Purposes and Finance Committee.

Wednesday, April 14th

10.0 a.m. Council Meeting.

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PERSONAL

Birth.—Fishwick.—On March 3rd, 1954, to Cynthia, wife of Roy Fishwick, M.R.C.V.S., at Tunbridge Wells, a daughter—Susan Jane.

R.C.V.S. OBITUARY

Going, John (Major, late R.A.V.C.), 7, Brackendale, Potters Bar, formerly of the Sudan Veterinary Service. Graduated London, July 18th, 1912. Died suddenly, March 4th, 1954.

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REPRINTS OF ARTICLES

The Librarian of the Royal College of Veterinary Surgeons would welcome reprints of papers by members, particularly those which appear in journals not wholly devoted to veterinary matters. It is felt that much valuable material which might be drawn to the attention of those interested is now missed. A file of reprints for loan would do much to cut down the increasing costs of packing and postage.

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AMERICAN APPOINTMENT OPEN TO PATHOLOGIST

Readers may be interested to hear of a Residency in Pathology for a term of 12 months, or more, which is being offered by the Angell Memorial Animal Hospital of Boston, Massachusetts. Included in the appointment will be the opportunity to attend lectures in pathology at Harvard Medical School and certain other lectures on pathology and related subjects in Boston.

The Angell Memorial Animal Hospital is a teaching hospital having a veterinary staff of 17, of whom five or six are employed as interns for periods of up to 15 months.

On this occasion it is hoped to appoint a veterinarian having several years' experience in pathology. The minimum salary is $3,000 a year, though it is possible that this amount would be offered for a six-month period to anyone especially well qualified. In any case payment of more than the minimum salary may be made according to qualifications and experience. The successful candidate will be asked to start work about August 1st, 1954, and those interested should communicate with Dr. Gerry B. Schnelle, Chief of Staff, Angell Memorial Animal Hospital, 180, Longwood Avenue, Boston 15, Massachusetts.

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SHEPHERDING AT ATTINGHAM PARK

Sponsored by Herefordshire, Warwickshire, Staffordshire, Worcestershire and Shropshire, and organised by the Education Committee of the latter, a very successful course for shepherds was held at Attingham Park, near Shrewsbury. The shepherding course is the second of its kind to be held there; it follows a similar very successful course held about the same time last year.

The students, numbering about 30 including four girls, assembled on Monday night, February 1st, when they were addressed by Professor Bywaters, of Leeds University, on the place of sheep in modern British agriculture. The daily routine followed a common plan, in that lectures were held in the morning whilst the afternoon was reserved for work of a practical nature. The evenings were taken up by lectures, film shows and, on the last night, a farm forum. The last-mentioned was in the nature of a "brains trust" in which written questions submitted by the students were answered by members of the forum.

On Tuesday Mr. T. W. Jones lectured on buying and fattening store sheep in addition to demonstrating the important features which should be noted when estimating the weight of a sheep. Later in the day the students were able to examine carcases of animals at the Shrewsbury abattoir which had been graded on the hoof by them. Mr. Chilman, a breeder of Clun Forest sheep, spoke to the young shepherds on Wednesday on the care of the ewe flock before and after lambing. In the afternoon Mr. Chilman, assisted by Mr. Price, who breeds Kerry hill sheep, demonstrated the handling of sheep and their preparation for show and sale. On Thursday Mr. L. E. Hughes spoke to them on some factors which determine the health of sheep and on some of the common diseases. The afternoon was occupied by demonstrations of drenching, paring the feet and the inoculation of lambs against lamb dysentery. The last day was taken up by Mr. Sinnet, who, in addition to speaking on the care of the sheep dog, demonstrated his methods when using this animal.

The students enjoyed this course immensely and the opportunity of living together at Attingham Park for the week. They dispersed on Friday mid-day after a most profitable and pleasant time.

L. E. H.

PROFITS FROM PIG-KEEPING

At a pig-keeping conference held in Ayr, Mr. James A. Gilchrist, Advisory Economist to the West of Scotland Agricultural College, said that the College had been making annual profits of £3,000 in recent years. 'On a four-year average the profit per sow at Auchincruive was £110, the cost per pig sold was £18 6s. for the year 1952-53, and the average sale price was £24 4s., leaving a profit per pig of £5 18s. The number of pigs sold during the year was 448.

Mr. James M. Thomson, Farm Manager at Auchincruive, spoke on the management of the pigs. He emphasised the need for a good strain of the chosen breed since there might be as much as half a pound difference in the amount of weight put on per pig per day between pigs of different strains.

The young pigs after weaning at eight weeks were transferred to the fattening house. The average weight at weaning was 30 lb. and the number of pigs from each farrowing at Auchincruive has risen from 6·40 in 1947 to 8·30 in 1952. The young pigs were fed on a balanced meal mixture until they reached an average of 70 lb. live weight.

Describing experiments to compare the results of controlled feeding with self-feeding, Mr. Thomson said that more weight was put on with the latter and that it amounted to 5 lb. per 100 lb. live weight. The controlled rate was raised to 6 lb., but the self-feeding figures still had the advantage. The conversion rate for controlled feeding was 2·92 lb. meal for every 1 lb. live-weight increase and for self-feeding 3·01 lb. meal for every 1 lb. live-weight increase.

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BRITISH TURKEY FEDERATION

Third Annual Conference

The British Turkey Federation held their third annual conference at the Hotel Majestic at Blackpool from February 8th to 11th. A varied selection of papers were given by poultry officers of the National Agricultural Advisory Service, by Dr. Temperton, of Harper Adams, by Dr. Carpenter, of the Rowett, Mr. Marshall, of Papworth Industries, who is acknowledged a leader in the field of incubation, by Dr. P. Blount and others.

Three members of the veterinary profession took part in this conference: Mr. J. Wilson, of Lasswade, read a paper on "What's New in Turkey Diseases," Dr. Blount gave a paper on "The Effects of Antibiotics on Turkeys," and Dr. W. M. McKay acted as Chairman of one of the sections on nutrition.

The conference was very well attended by farmers interested in the turkey industry from Scotland, Ireland, Wales and every part of England.

This progressive Federation appears to be consolidating its position, and the friendly collaboration between the scientists and the farmer is maintained at a higher level than in any similar organisation in the country.

It is intended that next year's annual conference will be held in either Brighton or Eastbourne.

W. M. McK.

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BREEDING OF LIGHT HORSES

The premium stallion scheme sponsored by the Hunters' Improvement and National Light Horse Breeding Society enables the small breeder—for example, the farmer who has a useful half-bred mare from whom he has hopes of good progeny—to obtain the services of a thoroughbred stallion, often of notable performance on the flat or over the jumps and of unimpeachable breeding and health, at the nominal fee of three guineas.

Apart from three allotted to Scotland, 46 premiums are offered for various parts of the country. Thus is ensured a probable annual increment to the light horse population of about 2,000 foals, well bred and obtained at an almost negligible cost to the breeder. What the result is may be seen each year at the Society's annual produce show at Shrewsbury.

Many top class hunters, point-to-point winners, show jumpers and other notable saddle horses come from this source, and two of the most famous animals in the world were by premium stallions. Lieut.-Colonel Llewellyn's Foxhunter, for instance, was by Erewhemos and another, Mrs. Baker's Starlight, who won the European individual championship at the three days' event at Badminton last year, was by Trappeur II.

FOOT-AND-MOUTH DISEASE

Foot-and-mouth disease was confirmed on Friday, March 5th, among pigs at Wisbech, Isle of Ely, and an area extending for approximately 15 miles around the infected premises has been declared to be an infected area.

Animals may not be moved in the area without a licence and the holding of markets within the area is restricted.

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ADDRESSES OF DISEASE-INFECTED PREMISES

The list given below indicates, first, the county in which are situated the premises on which disease has been confirmed, followed by the postal address and date of outbreak.

Anthrax:

Ches.—West Bank Field, West Marsh Farm, Frodsham Marshes, Frodsham, Warrington (Mar. 3).

Montgomery.—Cwmearl Farm, Sarn, Newtown (Mar. 1).

Renfrew.—Craigmuir Farm, Bishopton (Mar. 2).

Somerset.—Home Field, Upton Bridge Farm, Long Sutton, Langport (Mar. 1).

Yorks.—High Cragg Farm, Lartington, Barnard Castle (Mar. 1)

Foot-and-Mouth Disease:

Cambs.—Council Allotment No. 402, New Bridge Lane, Wisbech (Mar. 5).

Middx.—Orchard Bungalow, Halton Road, Bedfont (Mar. 7).

Fowl Pest:

Devon.—Merrifield, Woodland, Ashburton, Newton Abbott (Mar. 1).

Hunts.—2, Silver Street, Eynesbury, St. Neots (Mar. 3).

Leics.—New Farm, Peatling Parva, Rugby (Mar. 1); 37, Gough Road, Leicester (Mar. 5).

Lancs.—Finches Farm, North Road, Bretherton, Preston (Mar. 1); 53, Chapel Road, Hesketh Bank, Preston; Oakleigh, Gill Lane, Longton, Preston; Rear of Stanward Terrace, Abbey Village, Withnell, Chorley (Mar. 2); Slate Farm Hall, Carr Lane, Longton; Elm Tree Farm, Moss Lane, Little Hoole; Silver Tree, Ship Lane, Hutton, Preston (Mar. 3); Rosedene, Moss Lane, Little Hoole, Preston (Mar. 4); Marsh Road, Hesketh Bank, Preston; Douglas House, Liverpool Old Road, Much Hoole; The Gables, Liverpool Road, Rufford, Ormskirk (Mar. 5); Seaview, Much Hoole; Tusons Farm, Gill Lane, Longton, Preston (Mar. 6); Lynwood, Pine Avenue, Little Hoole; Joley's Farm, Town Lane, Much Hoole, Preston (Mar. 7).

Lincs.—"Chilvern" and "Alphin," Lincoln Lane, Metheringham (Mar. 4); Lincoln Lane, Metheringham, Lincoln (Mar. 6).

Norfolk.—Thorpe Hall, Mandham, Harleston (Mar. 2); Walnut Tree Farm, Besthorpe, Norwich (Mar. 4).

Yorks.—59, Millhouses Allotments, Archer Road, Millhouses, Sheffield (Mar. 4).

Swine Fever:

Beds.—New Bedford Road Allotments, Nr. Stockingstone Road, Luton (Mar. 2); 121, Biggleswade Road, Upper Caldecote, Biggleswade (Mar. 4).

Cambs.—Rectory Road, Tydd St. Mary, Wisbech (Mar. 2).

Ches.—2, Spruces Cottages, Runcorn Road, Moore, Warrington; Home Farm, Cuddington, Northwich (Mar. 1); Hankelow Manor, Hankelow, Crewe; Woodhouse Holding, Weston, Runcorn (Mar. 2); Alpraham Green Cottage, Alpraham, Tarporley (Mar. 4).

Fife.—Lynn Farm, Saline, Dunfermline (Mar. 2); Crombie Point Piggery, Torryburn, Dunfermline (Mar. 4).

Lancs.—Green Lane Piggeries, Heywood (Mar. 6).

Leics.—The Farm, Hose, Melton Mowbray (Mar. 2).

Notts.—Birk House Farm, High Street, Misson, Doncaster (Mar. 1); Reindeer Inn, East Bridgeford (Mar. 4).

Staffs.—Moss House Farm, Bignall End, Audley, Stoke-on-Trent (Mar. 6).

Suffolk.—Loft Farm, Bradfield Combust, Bury St. Edmunds (Mar. 1); Bay Farm, Worlington, Bury St. Edmunds (Mar. 2); Marsh Farm, Hulver Road, Mutford, Beccles; Buss Creek Allotments, Southwold; Freston Hill Cottages, Freston, Ipswich; Lodge Farm, Higham, Bury St. Edmunds (Mar. 5).

Surrey.—West Hill, Swimming Pool, Epsom (Mar. 3).

Warwicks.—Wharf Farm, Dickens Heath Road, Shirley, Birmingham (Mar. 1).

Wilts.—The Banks, Lyneham, Chippenham (Mar. 4).

Yorks.—Glaisby Farm, Stockton on Forest, York (Mar. 3).

CORRESPONDENCE

The views expressed in letters addressed to the Editor represent the personal opinions of the writer only and their publication does not imply endorsement by the B.V.A.

PROTRUSION OF THE INTERVERTEBRAL DISC IN THE DOG

Sir,—May I respectfully call your attention to an incorrect statement and inference in the article " Protrusion of the Intervertebral Disc in the Dog " (R. N. Smith and A. S. King) in the *Record*, January 2nd, 1954?

They state, " It now seems to be accepted in America that intervertebral disc protrusion is a clinical entity (*vide* ' Canine Surgery ' (Lacroix & Hoskins, 1949)). *Nevertheless*, in 1950 Schnelle (1950) appeared to infer that calcification follows the ' slipping ' of the whole disc and also that the conformation of the dog is one of the responsible factors." The reference is given as " Radiology in Small Animal Practice " 2nd edition (1950). This represents either a misquotation by Smith and King or an improper reference. In the text referred to by these gentlemen the subject is described on page 125 under the title of " Intervertebral Disc Protrusion and Calcification." No reference is made anywhere to " slipping " of the disc. If the authors would like to be corrected on their bibliography, they should be informed that the first reference to the intervertebral disc syndrome in dogs since Dexler (1896) was Schnelle, *The North American Veterinarian*, March, 1938, page 41, under the title of " Calcified Intervertebral Disc." A case is described in which the diagnosis was made by a radiograph, and since the patient recovered, the pathology of the disc was not studied.

The term " slipping " as applied to the disc was in the writer's text, " Radiology in Canine Practice," published in 1945 but submitted for publication (during war years) in 1943. On page 133 the syndrome is described under " Calcified Intervertebral Disc." The reference here is made to " slipped disc," the term being taken from the terminology of human medicine.

I would appreciate a correction of this erroneous inference of Smith and King.—Yours faithfully, Gerry B. Schnelle, Chief of Staff, The Angell Memorial Animal Hospital, 180, Longwood Avenue, Boston 15, Mass. *March 3rd*, 1954.

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NECROSIS OF EXTREMITIES

Sir,—Question No. 446 in a recent issue of *The Veterinary Record*, regarding necrosis of the extremities in suckling whelps, prompts me to record the following two cases:—

Case 1.—A six-month-old neutered male kitten in excellent physical condition was treated for acute pneumonia with Estomycin (Glaxo). The response was good, but a relapse occurred 10 days later. Again the condition responded to the same treatment and the kitten seemed fully recovered. After a further 10 days the tail, ears and toes were clearly suffering from a dry gangrene; there was no constitutional upset, but half the tail, the whole of both ears and most of the toes were separating before the kitten was destroyed.

Case 2.—A 10-year-old neutered female cat with an acute septic condition of the left hock (ascribed to cat bites) was treated with Crystamycin (Glaxo) and made good progress for four days and began to walk on the affected limb. Six days later a general decline set in and on examination the cat showed general toxaemia with extensive gangrene of the whole tail; an area over the right gluteal muscles, the tips of both ears and three toes were also affected.

In neither case was there any local reaction at the site of injection to indicate infection introduced by the syringe. In the first case there was no sign of infection and the kitten was cheerful and eating well when it was destroyed, but in the second case a gas-forming organism had either caused or contaminated the condition in the tail. The ear lesions, however, were quite dry.—Yours faithfully, R. E. Williams, Arkley House, 56, Rickmansworth Road, Pinner, Middlesex. *March 4th*, 1954.

VETERINARY CHRISTIAN FELLOWSHIP

Sir,—Would you kindly allow us space in your columns to bring to the notice of members of the profession the recent formation of the Veterinary Christian Fellowship. This is a section of the Graduates Fellowship which is affiliated to the Inter Varsity Fellowship.

It has become evident in the post-war years that there are increasing numbers in the veterinary profession who would like to be in touch with other veterinarians who share a common interest in the fundamental truths of Christianity. Most of the Veterinary Colleges have had Christian Unions which were affiliated to the Inter Varsity Fellowship, and it is known that many previous members of these unions have kept in touch with one another in various ways. Since the assimilation of the Colleges within the Universities students have access to the University Christian Unions, connected with the Inter Varsity Fellowship, which exist in most British Universities and in many abroad. The Graduates Fellowship is inter-denominational in character and is an organisation whereby older members of the profession may be linked with younger graduates and also with the student organisations.

Members of the profession will be interested to hear that the Graduates Fellowship has had research scientists, dental and medical sections for some time. There is also to our knowledge at least one other country, namely, Denmark, whose veterinary profession has a well-established similar Christian organisation. Will all those interested in the Veterinary Christian Fellowship write to the Secretary, Graduates Fellowship, 39, Bedford Square, London, W.C.1, for further particulars?—Yours faithfully, Sydney Jennings, Glasgow University; Kenneth Davis, Ilfracombe; Clement Fennell, Odiham. *March 6th*, 1954.

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Advertisers' Announcements

Introduction of Entavet

Allen & Hanburys Ltd. announce that Entavet is an oral preparation of streptomycin and sulphaguanidine for the treatment of calf scours, diarrhoeas of dogs and cats and enteritis of swine.

It is supplied in bottles as a dry powder from which 4 fluid ounces of suspension may be prepared by the addition of cold water.

New Strength Penicillin Veterinary Cerate

Glaxo Laboratories Ltd. announce the introduction of Procaine Penicillin G Veterinary Cerate containing 300,000 units procaine penicillin G per tube. This new strength cerate is of special value in the treatment of animals on outlying farms, as it provides adequate therapeutic penicillin levels for at least six or seven days. It is supplied in boxes of 12 single dose tubes.

DISEASES OF ANIMALS ACT, 1950—GREAT BRITAIN

Summary of Returns of Confirmed Outbreaks of Scheduled (Notifiable) Diseases

Period	Anthrax	Foot-and-mouth	Fowl Pest	Sheep Scab	Swine Fever
1st to 15th February, 1954	14	1	50	—	41
Corresponding period in—1953	48	15	13	—	84
1952	20	5	7	—	47
1951	25	2	110	1	51
1st January to 15th February, 1954 ...	36	3	236	—	170
Corresponding period in—1953	174	18	146	—	199
1952	62	22	39	—	114
1951	81	15	368	4	124